Chapter.1
SELECTING ASPHALT CEMENTS

General

Asphalt cements for use in pavement design and construction are graded or classified in one of two ways. Grading can be done on the basis of penetration depth of a standard test needle into asphalt cement at a standard test temperature. The other method of grading is based on the use of a viscosity test. Currently, in the continental United States (CONUS), viscosity grades of asphalt are common. However, outside the continental United States (OCONUS), penetration grades of asphalt may be more easily obtained. Tables 1 and 2 give specifications for the two types of viscosity graded asphalts. Table 3 gives specifications for penetration grades. All three tables are from current standards of ASTM D 3381 for viscosity grades and ASTM D 946 for penetration grades.

Selecting a grade of asphalt cement should be based on several items. Among the most important are climate, traffic conditions, economics of asphalt availability, and previous regional experiences. Traffic conditions and economic considerations will vary from project to project, but environmental conditions and regional experiences should have some similarity. For example, warm and hot regions should have similar experiences in avoiding unstable asphalt concrete mixes during the summer months, and cold regions should have similar experiences in avoiding crack-prone pavements during winter months.

Asphalt Cement Selection by Temperature Region

Table 4 gives guidance for selecting an asphalt cement by temperature region. Climatological data are required to provide input into the selection method. First, average monthly maximum temperature data are required to compute a pavement temperature index (PTI).[1] When project locations have average monthly maximum temperatures above 75" F (23.9' C), the PTI is defined as the sum of the monthly increments exceeding 75° F (23.9' C). Conversely, when no monthly temperature exceeds 75" F (23.9' C), the PTI is defined as the difference between the highest average maximum temperature for the warmest month and 75° F (23.9' C). Enclosure 2 (Example 1) shows an example of PTI computations.

When it is determined that a project will exist in a cold region, as defined in Table 4, additional climate data are required. For the project area under consideration, a design air freezing index (DFI) is also required to further satisfy cold region requirements. (Reference TM 5-818-2/AFM 88-6, Chap. 4 for determination of DFI.) Cold regions are areas where the penetration-viscosity number (PVN) method is used to aid in selecting an asphalt cement.

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[1] Headquarters, Departments of the Army and the Air Force, Bituminous Pavements Standard Practice, TM 5-822-8/AFM 88-6, Chap. 9.

Table 1

Requirements for Asphalt Cement Viscosity Graded at 140° F (60° C)[1]

(Grading Based on Original Asphalt)

Test	Viscosity Grade					
	AC - 2.5	AC - 5	AC - 10	AC - 20	AC - 30	AC - 40
Viscosity, 140° F (60° C), P	250 ± 50	500 ± 100	1,000 ± 200	2,000 ± 400	3,000 ± 600	4,000 ± 800
Viscosity, 275° F (135° C), min, cSt	125	175	250	300	350	400
Penetration, 77° F (25° C), 100 g, 5 s, min	220	140	80	60	50	40
Flash point, (Cleveland open cup), min, ° F (° C)	325 (163)	350 (177)	425 (219)	450 (232)	450 (232)	450 (232)
Solubility in trichloroethylene, min, percent	99.0	99.0	99.0	99.0	99.0	99.0
Tests on residue from thin-film oven test viscosity, 140° F (60° C), max, P	1,250	2,500	5,000	10,000	15,000	20,000
Ductility, 77° F (25° C), 5 cm/min, min, cm	100[2]	100	75	50	40	25

[1] From American Society for Testing and Materials Standard Specification D 3381-83, Table 2.

[2] If ductility is less than 100, material will be accepted if ductility at 60° F (15.5° C) is 100 minimum at a pull rate of 5 cm/min.

Table 2

Requirements for Asphalt Cement Viscosity Graded at 140" F (60" C)[1]

(Grading Based on Residue from Rolling Thin-Film Oven Test)

Tests on Residue from Rolling Thin-Film Oven Test[2]	Viscosity Grade				
	AR-1000	AR-2000	AR-4000	AR-8000	AR-16000
Viscosity, 140" F (60° C), P	1,000 ± 250	2,000 ± 500	4,000 ± 1,000	8,000 ± 2,000	16,000 ± 4,000
Viscosity, 275° F (135° C), min, cSt	140	200	275	400	550
Penetration, 77" F (25° C), 100 g, 5 s, min	65	40	25	20	20
Percent of original penetration, 77° F (25° C), min	--	40	45	50	52
Ductility, 77° F (25° C), 5 cm/min, min, cm	100[3]	100[3]	75	75	75
Tests on original asphalt: Flash point, (Cleveland open cup), min, ° F (° C)	400 (205)	425 (219)	440 (227)	450 (232)	460 (238)
Solubility in trichloroethylene, min, percent	99.0	99.0	99.0	99.0	99.0

[1] Prom American Society for Testing and Materials Standard Specification D 3381-83, Table 3.

[2] Thin-film oven test may be used but the rolling thin-film oven test shall be the referee method.

[3] If ductility is less than 100, material will be accepted if ductility at 60" F (15.5" C) is 100 minimum at a pull rate of 5 cm/min.

Table 3

Requirements for Asphalt Cement Graded by Penetration at 77° F (25" C)[1]

(Grading Based on Original Asphalt)

Test	Penetration Grade 40 - 50 Min	40 - 50 Max	60 - 70 Min	60 - 70 Max	85 - 100 Min	85 - 100 Max	120 - 150 Min	120 - 150 Max	200 - 300 Min	200 - 300 Max
Penetration at 77° F (25" C) 100 g, 5 s	40	50	60	70	85	100	120	150	200	300
Flash point, ° F (Cleveland open cup)	450	--	450	--	450	--	425	--	350	--
Ductility at 77" F (25° C) 5 cm/min, cm	100	--	100	--	100	--	100	--	100[2]	--
Solubility in trichloroethylene, percent	99.0	--	99.0	--	99.0	--	99.0	--	99.0	--
Retained penetration after thin-film oven test, percent	55+	--	52+	--	47+	--	42+	--	37+	--
Ductility at 77" F (25" C) 5 cm/min, cm after thin-film oven test	--	--	50	--	75	--	100	--	100[2]	--

[1]From American Society for Testing and Materials Standard Specification D 946-82, Table 1.

[2]If ductility at 77" F (25" C) is less than 100 cm, material will be accepted if ductility at 60 ° F (15.5" C) is 100 cm minimum at the pull rate of 5 cm/min.

Table 4

Asphalt Cement Selection Criteria Based on Pavement Temperature Index

Pavement Temperature Index, Cumulative °F ("C)	Temperature Region	Asphalt Cement Selection Criteria
Less than 30 (16.7)	Cold	Penetration-viscosity method for cold regions (Table 5)
30 to 80 (16.7 to 44.4)	Warm	85 to 100 penetration (original asphalt)
Greater than 80 (44.4)	Hot	60 to 70 penetration (original asphalt)

DFI's are used to differentiate between climates in cold temperature regions. A DFI of 3,000 degree-Fahrenheit-days (degree-days) or 1,667 degree-Celsius-days is used as the delineation between moderately cold and severely cold (extremely cold) climates. Moderately cold climates have DFI's up to 3,000 degree-days, and severely cold climates have DFI's greater than 3,000 degree-days.

Penetration-Viscosity Number: For Cold Regions

Penetration-Viscosity Number (PVN), also called Pen-Vis Number, is an empirical correlation between asphalt cement factors and low temperature pavement cracking experiences in Canada. Asphalt cement factors considered in the original correlation were penetrations at 77" F (25" C), viscosity at 275" F (135° C), and penetration index.[2] McLeod[3] proposed PVN for selecting asphalt cements to prevent low temperature cracking of asphalt concrete pavements. The PVN method is used to quantify temperature susceptibility of an asphalt cement and estimate its ability to prevent low-temperature cracking.

Required input data are penetration at 77" F (25° C) and kinematic viscosity at 275" F (135° C). Figure 1 allows estimation of PVN for asphalt cements in cold regions. Table 5 provides minimum PVN selection criteria for asphalts in cold regions. Table 5 and Figure 1 should always be used when selecting asphalts for use in cold regions. Table 5 also shows requirements for airfields and roads and other pavements. A design index is required for

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[2] Ad Hoc Committee, "Design Techniques to Minimize Low-Temperature Asphalt Pavement Transverse Cracking," Research Report 81-1, Asphalt Institute, December 1981.

[3] McLeod, N. W., "A 4-Year Survey of Low-Temperature Transverse Pavement Cracking on Three Ontario Test-Roads," Proceedings, Association of Asphalt Paving Technologists, Vol. 41, 1972.

Table 5

Minimum PVN Selection Criteria for Asphalt Cements in Cold Region Use

Cold Region	Airfields	Roads and Other Pavements by Design Index 6 4	Roads and Other Pavements by Design Index > 4
Moderate cold (DFI ≦ 3,000 degree-days*)	-0.5	-0.5	-0.5
Severe cold (DFI > 3,000 degree-days*)	-0.2	-0.5	-0.2

* Degree-Fahrenheit-days (1,667 degree-Celsius-days).

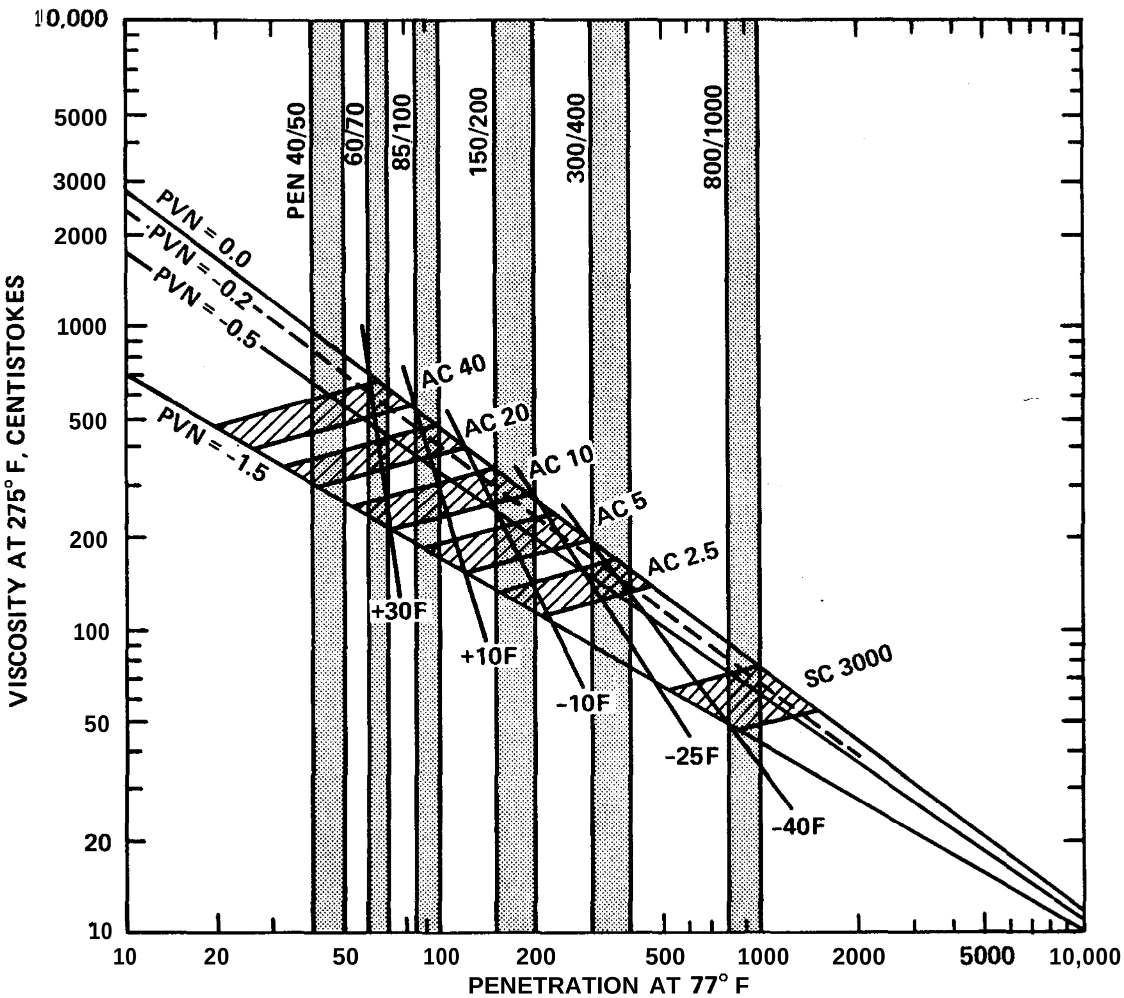

Figure 1. PVN chart for cold region asphalt selection (McLeod 1972)

roads and other pavements; it is an index of traffic estimate and is defined in TM 5-822-5/AFM 88-7, Chap. 3.

Temperature at a 2-in. depth of pavement can be estimated from a DFI for a given project location or site as shown in Figure 2. This "minimum anticipated pavement temperature" and minimum PVN criteria of Table 5 can be used with Figure 1 to select an asphalt cement.

An asphalt with given penetration and viscosity can be checked for satisfying PVN criteria of Table 5 by plotting in Figure 1. If its penetration and viscosity point falls on or above the minimum PVN value and to the right of the minimum anticipated pavement temperature, it is estimated that low temperature contraction cracking of the asphalt concrete layer will be prevented. If it plots to the left of the anticipated pavement temperature, the pavement will likely crack at low temperatures. PVN values should be calculated for more accurate results.

Examples of Asphalt Cement Selection

Enclosure 2 contains examples of asphalt cement selection by use of this Engineer Technical Letter.

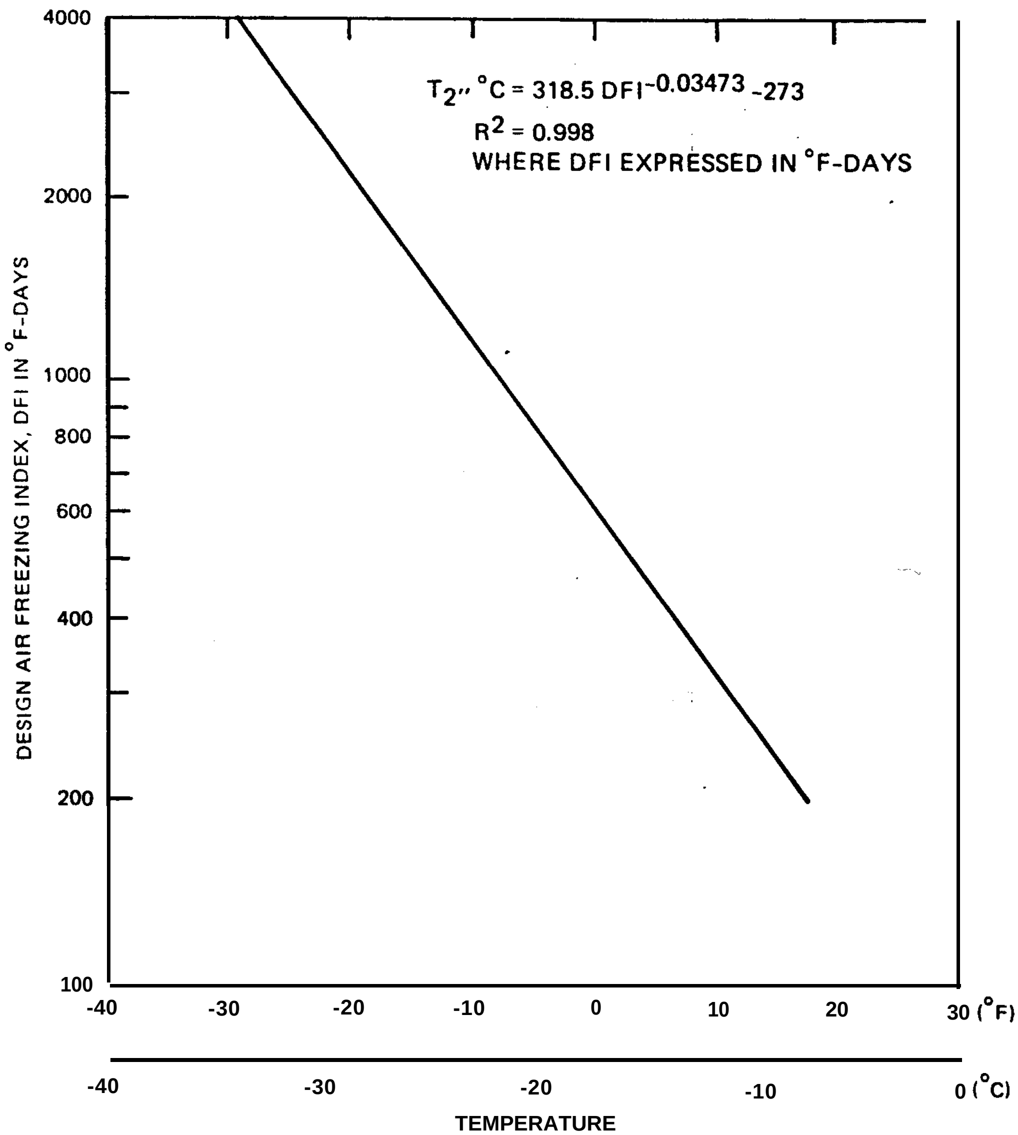

Figure 2. Pavement temperature as a function of design air freezing index